MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 303: PUBLIC HEALTH ENGINEERING I

DATE: 25/8/2022 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

- *This paper comprises of FIVE questions. Answer **THREE** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer any other **TWO** questions*
- *Reasonable assumptions should be made where necessary*

QUESTION ONE (30 MARKS)

a) Define the following terms and phrases and describe the significance of each in context of coagulation and flocculation and water treatment: (4 marks)

   i. coagulant aid
   ii. coagulant
   iii. charge neutralization
   iv. destabilization

b) Explain the role of coagulation and flocculation and explain how they fit into the overall process train for a surface water treatment plant. (5 marks)

c) Describe the chemicals used as coagulants and the primary mechanisms that coagulants use to destabilize particles. (6 marks)

d) pH and dose of coagulants is critical in the optimization of the coagulation operation. Briefly outline the procedure used in water treatment works to determine the most suitable dose and pH for coagulation efficiency. (5 marks)

e) State 5 basic water quality requirements for drinking water giving a reason (s) for each requirement. (5 marks)

f) Sedimentation is the separation of suspended particles that are heavier than water by gravitation settling. Give 5 water and wastewater treatment processes where this operation is used. (5 marks)

QUESTION TWO (20 MARKS)

a) Calculate the terminal settling velocity for sand in water at $10^{\circ}C$ having particle diameters of 50 and 190 μm and a density of 2650 kg/m^3. (5 marks)

b) Identify and describe the four types of settling. (4 marks)

c) Explain the purpose of filtration in water treatment and give a general description of the process of membrane filtration. (6 marks)

d) Explain why rapid granular filters must have coagulation pretreatment to be effective but membrane filters do not. (5 marks)

QUESTION THREE (20 MARKS)

a) Aeration occasionally is required in water treatment. Briefly show when and where this becomes necessary. Hence or otherwise give the conditions necessary for its effectiveness in water treatment and other associated benefits accruing from the aeration operation. (5 marks)

b) A small community water supply scheme is considering rainwater harvesting as the source of the supply. Design the roof catchment area required for a discharge of 1000litres/day if the 90% probability annual rainfall for the area has been estimated by the meteorological department to be 800mm. (5 marks)

QUESTION FOUR (20 MARKS)

a) Describe the three strategies used to reduce microbial contaminants in water treatment (3 marks)

b) Describe the characteristics of disinfectants commonly used in municipal drinking water treatment and the trends regarding their use. (4 marks)

c) Identify the specific chlorine species present in free chlorine and combined-chlorine residuals. Identify which disinfectant is most effective germicidally. (4 marks)

d) Explain how the production of disinfection by-products affects the ability to accomplish effective disinfection. (2 marks)

e) Describe issues associated with maintaining a combined-chlorine residual in large water distribution systems. (2 marks)

f) Migingo Town has an existing horizontal –flow sedimentation tank with an overflow rate of $0.708m^3/h.m^2$. What percentage removal should be expected for each of the following particle settling velocities in an ideal sedimentation tank: 0.01cm/s, 0.02cm/s and 0.1cm/s. (5 marks)

QUESTION FIVE (20 MARKS)

a) You have been tasked as a Consulting Engineer to design a water supply scheme for a high-class housing suburb in Webuye town and the design life of your system is to end in the year 2030. The demand for the suburb is described purely as residential. The population in this section of town has been obtained by census every 10 years by the Kenya National Bureau of Statistics as tabulated below. Calculate the initial, future and ultimate water demand using 2010 as the initial (base year). The design population in the town should be estimated using geometric growth projection. (20 marks)

Year	Population
1930	125000
1940	150000
1950	150000
1960	185000
1970	185000
1980	210000
1990	280000
2000	320000

CONSUMER	UNIT	***RURAL AREAS***			URBAN AREAS		
		High potential	Medium potential	Low potential	High Class Housing	Medium Class Housing	Low Class Housing
People with individual connections	1/head/ day	60	50	40	250	150	75
People without connections	1/head/ day	20	14	10	-	-	20
Livestock unit	1/head/ day	50			-		
Boarding schools	1/head/ day	50					
Day schools with WC without WC	1/head/ day	25 5					
Hospitals Regional District other	1/bed/ day	400) 200) 100) + 20 1 per outpatient and day (minimum 5000 1/day)					
Dispensary and Health Centre	1/day	5000					
Hotels High Class Medium Class Low Class	1/bed/ day	600 300 50					
Administrative offices	1/head/ day	25					
Bars	1/day	500					
Shops	1/da	100					
Unspecified industry	1/ha/day				20,000		
Coffee pulping factories	1/kg	25 (when recirculation of water is used).					

TABLE 1.3 Viscosities of Water and Air

Temperature (°C)	Water: Viscosity (μ) $N \cdot sec/m^2$	Water: Kinematic Viscosity (ν) m^2/sec	Air: Viscosity (μ) $N \cdot sec/m^2$	Air: Kinematic Viscosity (ν) m^2/sec
0	1.781×10^{-3}	1.785×10^{-6}	1.717×10^{-5}	1.329×10^{-5}
5	1.518×10^{-3}	1.519×10^{-6}	1.741×10^{-5}	1.371×10^{-5}
10	1.307×10^{-3}	1.306×10^{-6}	1.767×10^{-5}	1.417×10^{-5}
15	1.139×10^{-3}	1.139×10^{-6}	1.793×10^{-5}	1.463×10^{-5}
20	1.002×10^{-3}	1.003×10^{-6}	1.817×10^{-5}	1.509×10^{-5}
25	0.890×10^{-3}	0.893×10^{-6}	1.840×10^{-5}	1.555×10^{-5}
30	0.798×10^{-3}	0.800×10^{-6}	1.864×10^{-5}	1.601×10^{-5}
40	0.653×10^{-3}	0.658×10^{-6}	1.910×10^{-5}	1.695×10^{-5}
50	0.547×10^{-3}	0.553×10^{-6}	1.954×10^{-5}	1.794×10^{-5}
60	0.466×10^{-3}	0.474×10^{-6}	2.001×10^{-5}	1.886×10^{-5}
70	0.404×10^{-3}	0.413×10^{-6}	2.044×10^{-5}	1.986×10^{-5}
80	0.354×10^{-3}	0.364×10^{-6}	2.088×10^{-5}	2.087×10^{-5}
90	0.315×10^{-3}	0.326×10^{-6}	2.131×10^{-5}	2.193×10^{-5}
100	0.282×10^{-3}	0.294×10^{-6}	2.174×10^{-5}	2.302×10^{-5}